Action-embedded transformational leadership in self-managing global information systems development teams

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ABSTRACT

While software development teams are becoming more and more distributed around the globe, most software development methodologies used by global teams prescribe self-managing teams. Transformational leadership is the key to successful information systems development and use for competitive advantage. Yet, little is known about transformational leadership in self-managing global information systems development team settings. This study answers the research question of how leaders emerge and strategically influence systems development in self-managing global information systems development teams. This question is answered with a grounded theory study of Apache Open Source Software development teams. A theoretical model of action-embedded transformational leadership is developed to demonstrate how leaders emerge and strategically influence systems development efforts through their leadership, which is embedded in their work-related actions.

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1. Introduction

This study investigates how emergent leaders strategically influence systems development in self-managing global information systems development teams (SMG-ISDTs) through transformational leadership. Self-managing teams are groups of interdependent individuals who have the collective authority and responsibility of managing and performing relatively whole tasks to achieve group goals (De Jong et al., 2004). Transformational leaders generate awareness and acceptance among followers toward group goals. Transformational leadership exists when leaders move their followers to go beyond their own self-interests for the good of the group (Burns, 1978). Transformational leadership enables information systems (IS) development for competitive advantage by generating an innovative IS climate (Leidner et al., 2010; Watts and Henderson, 2006) and by contributing to business-IS alignment (Chan and Reich, 2011) thus increasing organizational performance (Chan and Reich, 2011; Leidner et al., 2010). This is in line with the arguments that the real sources of IS-based competitive advantage are the complementary capabilities, including the transformational IS leadership (Keen, 1993; Mata et al., 1995; Peppard and Ward, 1999; Powell and Dent-Micallef, 1997).

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Human resource issues associated with information systems are pertinent to the strategic information systems field and have often been addressed in JSIS (Galliers et al., 2012). Our study concentrates on the complementary human capability of transformational leadership in enabling global IS development for competitive advantage. We believe that leadership supports the process of IS enablement of competitive advantage, which is one of the research areas in the strategic information systems field (Gable, 2010). Our view is similar to the views adopted by previous JSIS authors interested in the use of IS for competitive advantage: For example, Andreu and Ciborra (1996) developed an organizational learning model to describe how IT applications can contribute to core capabilities development, therefore to competitive advantage. They suggested that managers could improve this IT transformation process by adopting certain leadership behaviors such as nurturing the learning process, and fostering a climate of sharing work practices. Similarly, Dehning and Stratopoulos (2003) found that companies with superior leadership skills are more likely to sustain IT-enabled competitive advantage. Likewise, in their conceptual paper, Peppard and Ward (2004) suggested that management of IT enables organizations to derive and leverage value through IT on an ongoing basis. While these researchers focused on organizations with formal managerial structures, in this study, we focus on novel organizational forms where such managerial structures may not be available, as explained below. In the remainder of this paper, we use the term *information systems* rather than *strategic information systems*, while acknowledging that information systems have the potential to provide competitive advantage together with complementary transformational leadership.

In this study, we examined transformational leadership within self-managing global information system development teams (SMG-ISDTs). In the early 1990s, Lambert and Peppard (1993) had estimated a move towards newer organizational forms characterized by self-managing teams. Furthermore, they had contended that these novel teams would require newer types of leadership that challenge traditional organizational assumptions. In recent years, with the flattening of organizations and increasing globalization (Oshri et al., 2007), there is indeed a move towards self-managing global (SMG) information systems development teams. The leadership of these teams tends to be emergent rather than top-down (Carmel and Sawyer, 1998). Yet, emergent IS leadership is under-studied (Avolio et al., 2000; Kahai et al., 2003). SMG-ISDTs have globally distributed members with a high degree of decision-making autonomy and behavioral control (adapted from Manz and Sims Jr., 1980). These groups are increasingly common in IS development (Carmel and Sawyer, 1998). Yet, despite what the term *self-managing* seems to indicate, self-managing teams may have external leaders or formal or informal administrative roles, which may or may not be viewed by the team members as a management role. In fact, much self-managing team research focuses on external leadership provided to these teams (e.g., Cohen et al., 1996; Druskat and Wheeler, 2003; Kirkman and Benson, 1999; Manz and Sims Jr., 1987). Similarly, SMG-ISDTs may come in different organizational forms: they may be standalone, they may reside in organizations or they may be cross-organizational. SMG-ISDT beneficiaries may include their participants, one or more organizations or a large community. Examples of SMG-ISDTs include Open Source Software development teams, which range from fully voluntary teams to company-based commercial teams (Wasserman, 2009).

The study of SMG-ISDTs' transformational leadership is timely for three reasons. First, existing research is limited to co-located teams (Judge and Bono, 2000); thus, it might transfer only partially to SMG-ISDTs due to the unique conditions of global teams (Carte et al., 2006; Hooijberg et al., 1997; Zhang and Fjermestad, 2006). Therefore focused studies of transformational leadership in the SMG-ISDT environments are needed.

Second, both strategic information systems literature and general transformational leadership research typically investigates managers' leadership. Peppard and Ward (1999) identify two main streams of leadership research in strategic information systems literature. One leadership stream examines the characteristics of either the IS director or the chief information officer. The other leadership stream relates the role of chief executive officer to an organization's IS-related activities. However, SMG-ISDTs depend on emergent leaders (Conger and Pearce, 2003). Hence, the findings in hierarchical settings may not be generalizable to non-hierarchical self-managing teams (Cummings, 1981; Hackman, 1986).

Third, leadership research focuses on leadership outcomes (Cascio and Shurygailo, 2003; Judge and Piccolo, 2004; Lowe et al., 1996); it does not explicate the leader emergence processes (Avolio et al., 2000; Kahai et al., 2003) and the influence processes (Balthazard et al., 2009) that are crucial to selection, training, and development of team members.

This study was intended to address these research gaps by investigating the following research questions: (1) How do leaders emerge as transformational leaders in SMG-ISDTs? (2) How do leader behaviors influence team outcomes?

2. Theoretical background

In this section, we first discuss the unique nature of leadership in IS development teams, which are increasingly becoming globalized. In an effort to address the unique leadership challenges, we introduce transformational leadership theory. Consequently, we provide a critical look at the transformational leadership literature and identify and uniquely combine other literature streams, which may address the gaps in the transformational leadership literature.

2.1. IS development teams and leadership

While leadership plays a crucial role in determining the success of IS development in organizations (Irani et al., 2005; Ravichandran, 2000; Thong et al., 1996; Wixom and Watson, 2001), IS leadership has both similarities to and unique

differences from leadership in other settings. IS development teams are cross-functional, their members bring multidisci-plinary knowledge, their work is characterized by time pressures, and their outcomes must be adaptive to changing stake-holder expectations, business and technology conditions (Faraj and Sambamurthy, 2006, p. 239). Some may argue that these team characteristics may overlap with other types of teams. Yet, IS developers inhabit a unique occupational subculture (Guzman, 2006; Guzman et al., 2004) and they operate in a setting where the project failure rate is so high that failure is seen as inevitable (Mahaney and Lederer, 2006). Furthermore, IS leaders require unique skills due to high task interdepen-dence and reliance on expertise distributed around the globe, which requires increasing dependence on global teams (Faraj and Sambamurthy, 2006).

Transformational leadership may provide the answer to these unique IS leadership challenges faced by multidisciplinary, global individuals operating under a unique subculture by using intellectual stimulation, promoting consideration of differ-ent viewpoints and inspiring collective action to enhance group potency and effectiveness (Sosik et al., 1998). While trans-formational leadership is typically researched in formal organizational contexts where the leaders and followers share the same geographical location, it may be possible to observe the type of communication, which is at the core of transforma-tional leadership in global team settings. Transformational leaders influence followers with communication, through which they set a vision and high standards and increase team cohesion (Bass et al., 2003), achieve team success (Waldman and Atwater, 1994), reduce social loafing (Avolio et al., 2000), and increase member performance (Bass et al., 2003). Transforma-tional leadership creates an innovative IS climate (Leidner et al., 2010; Watts and Henderson, 2006), contribute to business-IS alignment (Chan and Reich, 2011), and increase organizational performance (Chan and Reich, 2011; Leidner et al., 2010). Podsakoff and colleagues (1990) identified six types of transformational leadership behaviors. These are *articulating a vision* for the group, *being an appropriate role model*, fostering the *acceptance of group goals*, creating *high performance expectations*, providing *individualized support* and *intellectual stimulation to team members* (Podsakoff et al., 1990).

2.2. A critical look at the transformational leadership literature

There are a few criticisms about the transformational leadership research, identifying the gaps in this literature stream. In trying to fill these gaps, we identify other relevant literature (namely the emergent leadership literature and self-managing team literature) to better inform this study.

First, while IS researchers value and refer to transformational leadership, most have not explicitly researched it in IS set-tings other than few exceptions such as Neufeld et al. (2007), and Sosik et al. (1998). Neufeld et al. (2007) found a significant relationship between transformational leadership and performance expectancy, effort expectancy, social influence and facil-itating conditions. Sosik et al. (1998) examined the effects of transformational leadership on group potency and effectiveness in group decision support systems use. They found that higher levels of transformational leadership promoted higher levels of group potency and effectiveness. This effect depended on the levels of task interdependence.

Second, while much research is conducted on how transformational leaders impact followers, little research has been done to explain how transformational leadership influences team processes and performance (Conger, 1999; Dionne et al., 2004; Yukl, 1999). Among the few who attempted to explicate how transformational leaders influence team processes were Waldman and Atwater (1994), who asked interviewees which factors contributed to project success. Yet, while inter-viewees mentioned that lack of leader actions might hurt a project, they could not describe how transformational leaders contribute to team performance. Similarly, Kahai et al. (2003) showed that transformational leaders are able to keep participation and cooperation high, even when the members are anonymous, however, they did not explicate the process by which leaders achieve this. Thus, a research gap exists regarding how transformational leadership operates in teams.

Third, a critical look at transformational leadership research reveals an underlying assumption that leaders are the man-agers with vision, who influence and equip their followers, or in most cases their subordinates, who in turn perform the work to achieve organizational objectives (Yukl, 1999). The possibility that transformational leaders emerge informally, and that leaders also contribute to the work in achieving organizational objectives is eliminated by the usual research design em-ployed for transformational leadership, which consists of surveying subordinates about their managers. Therefore, a research gap exists in the study of transformational leadership in settings where leaders may be informal and emergent, rather than formal managers and where the followers are peers rather than subordinates. Self-managing team literature may be com-bined with the transformational leadership literature, in order to fill this research gap. Self-managing team literature inves-tigates groups of interdependent employees who have the collective authority and responsibility of managing and performing relatively whole tasks (De Jong et al., 2004). While self-managing teams are important especially for information systems development (Carmel and Sawyer, 1998), creating and leading such teams is a challenge (Moe et al., 2009) and participation may be resisted by the employees (Kirkman and Shapiro, 1997). While transformational leadership studies fo-cus on internal formal leaders, most studies of self-managing teams focus on how external formal leaders create certain gov-ernance structures in order to foster a team's self management (Wageman, 2001). Key findings show how formal external leaders design their teams (Manz and Sims Jr., 1987; Salas et al., 2005; Stewart and Manz, 1995), empower teams (Druskat and Wheeler, 2003), define the quality of their coaching (Stoker, 2008; Wageman, 2001) and influence team self-management and success. While the self-managing teams, by definition, suggest internal leadership (Manz and Sims Jr., 1987), studies of emergent leadership of self-managing team members are few (e.g., Crowston et al., 2007b; Eseryel, 2009, 2010; Eseryel et al., 2012). Thus, the study of how informal and emergent transformational leaders contribute to self-management of global teams may be informed by combining transformational leadership literature with the methods of emergent leadership

literature. When these two literatures are combined, emergent transformational leaders would be defined as group members who, without formal authority, exert significant influence over other members of the group and move them to perform above expectations (adapted from Schneider and Goktepe, 1983). One or more such leaders may emerge within a group (e.g., Jarvenpaa et al., 1998). In fact, in the IS environment, emergence and collaboration of several interdependent leaders may also be necessary for team success (Zhang and Faerman, 2007).

Emergent IS leadership is researched mostly by studying behaviors of perceived leaders (e.g., Carte et al., 2006; Crowston et al., 2007a; Misiolek and Heckman, 2005; Tyran et al., 2003; Yoo and Alavi, 2004). Identifying what perceived leaders do is valuable. However, to better understand emergent transformational leadership, it is vital to distinguish behaviors that bring about transformational leadership perception from general leader behaviors. Similarly it is important to distinguish transformational leadership behaviors that influence team outcomes positively from those leadership behaviors that may not be effective. To exemplify this need: Many researchers identify that emergent leaders are the most frequent communicators (e.g., Eseryel, 2010; Wickham and Walther, 2007; Yoo and Alavi, 2004). Yet, few go further to explicate which of these behaviors are also valid for transformational leaders, and which ones enable the transformational leaders to influence the group perceptions and outcomes positively. Indeed, there is no relationship between communication initiation and leadership perception (Wickham and Walther, 2007), therefore knowing that emergent leaders are frequent communicators is not sufficient for practitioners to emerge as a leader. Instead, for example knowing the connection between initiation of opinion contribution (rather than all communication) and leadership perception may be both practically and theoretically more useful (Weisband, 1992).

Currently, neither self-managing global team literature, nor its subset, the emergent team literature, intersects with transformational leadership literatures despite the increasing interest in transformational leadership. This may stem from the development of transformational leadership literature for formal manager-subordinate situations (Bass and Avolio, 2000). As informal transformational leadership may emerge in SMG team settings, studies need to combine transformational leadership, SMG team leadership, and emergent leadership.

In this section, we provided a critical look at the leadership literature related to IS development teams and identified the relevant leadership literatures that may help fill the gap in the existing literature. We then introduced these literatures as a baseline for our investigation of the emergence and influence of transformational leaders in SMG-ISDTs.

3. Research method

In the research method section, we first introduce the context of this study. This is followed by the description of the data collection and analysis method used.

3.1. Data and the context of the study: Apache Open Source Software development teams

We collected our data from Apache Open Source Software (OSS) development teams. In this section, we introduce the OSS concept in general, and provide comparisons between Apache OSS teams and organizational SMG-ISDTs on governance, team goals, end-customers, member motivations, team structure and leadership dynamics. This comparison shows how Apache OSS teams fit this study and how the findings can be generalized to similar organizational SMG-ISDTs.

OSS is computer software whose source code is available under an open source license that permits users to view and change software code. While this section is limited to an overview of OSS governance and leadership, a number of review articles summarize the overall OSS literature (Aksulu and Wade, 2010; Crowston et al., 2012; Feller and Fitzgerald, 2000; Lerner and Tirole, 2001; Nelson et al., 2006; Rossi, 2004; Scacchi, 2007; von Krogh and von Hippel, 2006).

Apache Open Source Software (OSS) development teams are ideal test-beds for this study because OSS teams are important to study in their own right as examples of surprisingly successful and innovative teams according to the US National Science Foundation (Ghosh, 2002). Indeed, open source software teams develop strategic information systems that may provide competitive advantage to the organizations using them (Hedgebeth, 2007; Lundell et al., 2011). Secondly, Apache OSS teams are examples of SMG-ISDTs. In terms of governance, Apache OSS teams are voluntary teams under the non-profit organization called Apache Foundation (Bonaccorsi and Rossi, 2006; Wasserman, 2009). Thus, similar to other organizational self-managing teams, Apache OSS teams have an umbrella organization with organizational structures, IS infrastructure, norms and reporting requirements (Ljungberg, 2000). Although this umbrella organization influences Apache teams, each team independently determines how it is going to function (The Apache Software Foundation, 2012) and therefore is a self-managing team.

The goals and end-customers of Apache OSS teams show similarities to organizational SMG-ISDTs: Apache projects are similar to cross-organizational teams with participants working for different companies, and their internal customers are the developers, and external customers may include the companies/clients of the developers and other end-users.

Lastly, team member motivations may range in both SMG-ISDTs and Apache OSS teams: Apache OSS team participants' motivations may be economical, social or technological in nature (Bonaccorsi and Rossi, 2006), including skill-development, future career benefits (Lerner and Tirole, 2001), scratching a personal itch (Feller and Fitzgerald, 2002) or for enjoyment (Green, 2000). Consequently, due to varying structures of SMG-ISDTs, we caution the readers to generalize our findings mainly to organizational OSS teams and SMG-ISDTs that are similar in terms of umbrella organization, structure, norms, end-customer, and member motivation to the Apache teams used for this study.

Apache OSS team structure is represented as an onion-like structure. At the center of this structure are the core developers who develop code, followed by bug-fixing co-developers, and bug-reporting active users and passive non-contributing users respectively (Crowston and Howison, 2006). While core developers may be candidates to be leaders, leadership roles of the core members cannot be claimed without further analysis (Fleming and Waguespack, 2005; Howison et al., 2006). Successful problem-solvers gain esteem in the eyes of other members (Fleming and Waguespack, 2005) and this translates into a higher potential for future leadership (Cox, 1998; Fleming and Waguespack, 2005; Gacek and Arief, 2004; Moon and Sproull, 2002; Scozzi et al., 2008). Similarly a leader may move from core to periphery, while still being perceived as a leader. While each Apache team has an administrative role called *project management committee chair*, this is an administrative coordination role and not necessarily a leadership role (Apache Software Foundation, 2007; Jensen and Scacchi, 2005).

3.2. Data collection

A qualitative approach, and specifically, a grounded theory approach, is chosen to identify relevant constructs that contribute to leadership emergence. At the core of any qualitative paradigm is the notion that people assign meaning to the objective world and to relevant phenomenon (such as leadership) (Tesch, 1990). People also assign meaning to their experiences that are situated within a social context (team context in this case) (Tesch, 1990). Leadership emergence in this study is a perceptual concept, rather than a formal role: A person is identified as a leader when others perceive them as a leader. Qualitative interviews allow researchers to derive interpretations from respondent talk (Warren, 2001). These types of studies are especially useful for developing theoretical insights when research focuses on areas that extant theory does not address well (Ozcan and Eisenhardt, 2009).

Twenty-five in-depth qualitative interviews were conducted with key informants from different Apache Software Foundation Members; participants were identified with the snowball sampling approach during annual Apache conferences between 2006 and 2010 (Table 1 provides information about the interviewees).

Snowball sampling is commonly used for theoretical sampling by qualitative interviewers, where one respondent is located who fulfills the theoretical criteria, then that person helps to locate others through their social networks (Arksey and Knight, 1999; Weiss, 1994). Snowball sampling started off with a personal contact at the Apache Board identifying the first key informant, who met the criteria below. Apache Board members are elected by Apache members to manage the Apache foundation's corporate assets. While the board does not interfere with the technical projects, its members typically have served the Apache foundation for a long time and have shown leadership within and across projects. Our first key informant was a long term member of Apache, had been a core member of a few projects as well as being a peripheral member of other projects. Each key informant was then asked to identify the next key informant based on the same criteria.

Key informants are defined as individuals who (1) have provided leadership on Apache projects for an extended period of time, (2) understood the nature of leadership on Apache teams, (3) closely followed a number of teams, and (4) were knowledgeable and willing to communicate about the leadership in these teams. Therefore they were in the best position to

Table 1
Demographics of 25 participants.

Characteristics	Values
Gender	
Male	23
Female	2
Age (Years)	
Range	21–52
Average	
Job	
Software Developer	14
Systems Administrator	3
Consultant	5
Trainer	2
Chief Architect	1
Involvement with Apache (Years)	
Range	1–15
Average	3.8
Number of Projects Currently Participated In	
Range	1–8
Average	3.2
Paid to Work at Apache?	
Yes	6
No	10
Partially (Use Apache for Consulting or For Work from time to time)	9

Table 2
Coding process.

Step	Coding process/description
1	Interviews are transcribed and read by the two researchers independently several times for familiarization
2	Researchers independently coded the text for leader behaviors and their outcomes
3	Researchers iteratively coded and discussed leader behaviors and their outcomes. Outcomes are divided among "influence on leader perception" and "strategic influence on technology development" in order to identify specific and meaningful sub-codes
4	Two researchers independently coded for sub-categories for each outcome. These sub-categories are discussed and final terminology is constructed by agreeing on code names, by merging or separating codes where necessary. Coding schema is finalized with descriptions and examples
5	Final coding is conducted using the coding schema

identify the leaders within the teams they observed. With purposeful selection of key informants, the actual number of participants is not as important as contributions of each participant to the greater understanding of the topic being researched (Ponterotto and Casas, 1991).

Interviews were semi-structured and lasted from 60 to 90 min. Our interview protocol (Appendix A) asked the interviewees to identify team leader(s). Follow-up questions elicited leadership behaviors by asking why the interviewees thought of each individual as a leader. In line with courtroom questioning, we emphasized the facts and we avoided generalizations by asking to each respondent specifically why they identified each individual as a leader, rather than asking general questions about leadership. Moreover, we posed critical probing questions to prompt the respondents to reflect deeper on their thinking and to further clarify their responses.

3.3. Data analysis

We transcribed and analyzed the data according to grounded theory methodology (Glaser and Strauss, 1967) to identify leadership behaviors that emerge from the data. The transcribed interviews ranged from 7 to 26 pages per interview (an average of 16.5 pages) and in total amounted to 414 pages. We conducted two levels of coding, open coding and selective (Charmaz and Mitchell, 2001). Table 2 summarizes the coding process.

Both researchers independently coded the data and categorized them through a process of constant comparison based on open coding principle (Strauss and Corbin, 1990). Inductive codes were then discussed until full agreement was reached. This discussion process involved understanding each other's terminology and merging those terms that referred to the same concept. Lastly, the coders applied selective coding by abstracting these codes to a higher-level coding category while synthesizing the data (Charmaz and Mitchell, 2001) and identifying meaningful categories. Appendix B shows the coding schema with the code names, descriptions and sample quotes.

4. Results

The findings of this study led to a theoretical understanding of transformational leadership in SMG-ISDTs. In this section an in-depth discussion of how transformational leadership emerges in SMG-ISDTs is provided.

4.1. Action-embedded transformational leadership in SMG-ISDT

Our findings suggest that transformational SMG-ISDT leaders reportedly generate awareness and acceptance among team members of the group goals. Individuals emerge as leaders through their consistently noteworthy contributions to their team over extended periods of time and through the inspiration they provide other team members. We call this phenomenon *action-embedded transformational leadership*.

A deeper analysis of the data reveals three important characteristics of the action-embedded leadership identified in Apache OSS teams. First, the actions of these perceived leaders help convey and put in place strongly held beliefs and values. Second, their actions stimulate innovative problem solving. Finally, the perceived leaders' actions generate high degrees of follower confidence in that the leaders protect the team. According to Bass (1997) these three characteristics are signposts of *transformational* leadership. Yet the key difference between SMG-ISDT transformational leadership and leadership observed within traditional hierarchical organizations is in the behaviors that bring about leadership perception. Most transformational leaders in traditional organizational settings do managerial tasks such as developing strategies and plans, communicating grand vision, and coordinating others. Followers of these leaders typically conduct the work in line with the vision of the leaders. Apache teams' action-embedded transformational leadership provides a major shift from both the existing transformational leadership literature and from the strategic information system literature by suggesting leaders actually work, a behavior typically attributed to followers. In fact, in Open Source development teams, the concept of meritocracy brings about this major shift. Meritocracy is the idea that individuals who contribute technically to the project gain more (informal) seniority in the project. As a result, these contributors bring about transformational outcomes from the bottom of the organization. But just how does the action-embedded leadership bring about such transformational outcomes in self-managing

global IS development teams such as Apache? To answer this question, the remainder of this section provides detailed insights from the data.

Twenty-four of twenty-five interviewees mentioned the importance of the actions of the leaders that contribute to work. As one interviewee put it:

He became a leader by actively, continuously coding and participating in our community.

When asked why they identify certain individuals as transformational leaders, interviewees commonly mentioned the leadership these individuals provided over long periods of time by significantly contributing to the software development effort. This is contradictory to how transformational leadership was typically identified in traditional organizational settings, in which work contribution is taken for granted since individuals are simply getting paid to do work. However, our data suggest that in SMG-ISDTs such as Apache, work contribution is considered as a leadership characteristic since it is a voluntary rather than a compulsory behavior: interviewees often mention their awareness of the voluntary nature of the work by making comments such as

We do this because we want to. There is no boss here. Nobody can order another person to do something.

Similarly in answering the question on why they view somebody to have been a leader, they use sentences that begin with "S/he took the initiative to" and that continued with description of the work they did, which enabled us to conclude on the role of voluntary contributions to work in emerging as a transformational leader.

Furthermore, our data suggests that action-embedded transformational leadership in Apache teams was a function of both the duration and intensity of the work contribution. All interviewees mentioned that many individuals exhibited spurts of such leadership behavior, which we call micro-leadership. However, in their identification of transformation leaders, interviewees differentiated between those who exhibit high levels of action-embedded leadership continually differently from those who exhibit some level of action-embedded leadership from time to time. As a perceived leader puts it:

You don't become a transformational leader by declaring "I'm now a leader" or by saying "I incepted the project so you must look to me for guidance." But it's actually how much and how long you work in the community that matters [for transformational leadership].

While interviewees referred to continuous intensive work over long periods, they were not able to pinpoint to a specific length of time that is sufficient for emergence as a transformational leader that would be globally valid for all projects. When further prompted, their responses indicated that the interviewees either did not know how long would be enough, or that they expected the time period would vary across projects. When prompted further, they were not able to name factors that may affect the length of time needed for transformational leader emergence. As the interviewees were not able to identify the factors that may affect the duration of work that would qualify an individual to be perceived as a leader, we believe this is an interesting and practically relevant area for future research.

A deeper synthesis of the identified quotes about action-embedded transformational leadership according to the grounded theory method yields a model of action-embedded transformational leadership in Apache teams, as explained below. This model (Fig. 1) suggests that action-embedded transformational leadership contributes to individual level outcomes for the perceived leaders as well as to the team level outcomes. Below we describe each component of the research model presented in Fig. 1. Table 3 presents sample quotes from the interviewees representing each component of the model.

Table 3
Sample quotes for each part of the model.

| Code name	Quote
Action-embedded transformational leadership	"S/he is a transformational leader not because of some formal title, but because s/he wrote the majority of the [software] code we use today" "I don't even know what the code looks like now, since s/he has made so many contributions since s/he came that s/he changed the workings of the software"
Influence of action-embedded transformational leadership behaviors on leader perception	
IT-knowledge perception	"S/he has been working very hard for a long time on this project. S/he knows both the [software] code [that we develop] inside out and s/he also has a lot of experience with the open source community.
Guardian perception	"You really know that s/he cares for the project and our community. S/he sees what may go wrong and s/he is not afraid to talk about them even if it's not pretty"
Role-model perception	"It is important to do something and not just talk about it. It doesn't have to be writing code, you can even contribute to documentation or website development. When you see people like him/her [referring to the transformational leader] work on the nitty–gritty, then you want to do the same"
Strategic influence on systems development	
SMG-ISDT effectiveness	"Things need to be processed quickly. S/he takes code and rewrites it in a way that makes it run, like, five times faster"
Transformation of technology vision	"I have an idea of where we should be headed. I do my work one chunk at a time so that we can really go there"
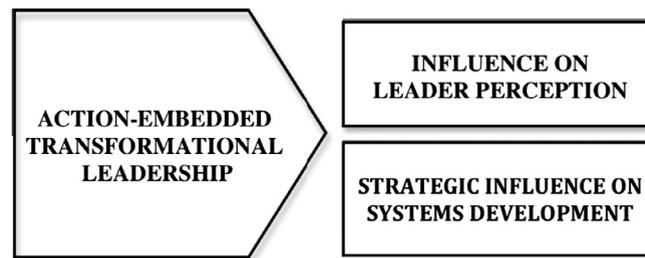
Fig. 1. Influence of action-embedded transformational leadership.

4.2. Influence of action-embedded transformational leadership behaviors on leader perception

4.2.1. IS knowledge perception

Eleven out of twenty-five interviewees mentioned that action-embedded transformational leaders have a strong understanding of the whole project as a result of their ongoing contributions. Their high level of contributions over long time-periods had allowed them to increase their technical skills and their knowledge of the internal workings of the project. Interview findings show that individuals perceive other individuals with strong technical and contextual knowledge as transformational leaders because they can use this knowledge to help others come up with innovative or improved solutions. An interviewee said the following about an individual(s) he perceives as a leader:

Because I've seen his (or her) work for a long time now, I know that s/he knows what s/he is talking about.

In another project, the founder, and the long term contributor of the project was identified as a leader because:

As we were writing the code together s/he gave us guidance on questions where the specifications were completely ambiguous. S/He would say, "well this server behaves this way, that server behaves that way". S/He would give us feedback. This allowed us to come up with solutions that we otherwise wouldn't have.

The ability to observe the work and discussion of those individuals over long periods of time due to the archived and transparent information and communication technologies enables all team members to form their views about each other's knowledge and experience as reflected in their work and opinions. For example, an interviewee noted:

Undoubtedly that project has such a leader, which is him [her], a very senior and experienced kind of person, who knows a lot about Apache and Java and about team management. How do I know this? I can see it in his (her) arguments on the listserv and on the work s/he does.

4.2.2. Guardian perception

Perceived leaders are also seen as guardians of the project in that they would do what is good for the project and avoid behaviors that would hurt the project or damage its community. Interviewees repeatedly mentioned that transformational leaders' actions "support the common good" and that these leaders "are always careful about not doing something that would hurt the project". In that sense, team members trusted that transformational leaders submitted good quality software code, and created general rules accepted by the community, which may be related to providing documentation or using a specific style of coding. When asked why s/he was considered as a leader, one interviewee mentioned:

I am just being my egoistical self by (...) doing things that I enjoy and then it sort of works out that it is for the common good.

Another quote shows that individuals who do not always consider what's best for the group are not considered as a leader:

... S/He tends to do things without necessarily making sure that it's the right thing to do, in terms of what we're allowed to do, the procedures we follow to write code or do things around here.

In other words, findings suggest that Apache team members watch their colleagues over long periods of time, and determine whether "their actions are good for the team." Thus, while one person is seen as a guardian of the project as a result of ongoing positive behaviors, this perception may change if the person starts acting in a way that may threaten the group dynamics or contribute to reducing the quality of the software.

4.2.3. Role-model perception

Interviewee data suggests that, in addition to the perceived level of knowledge and guardianship, a third indicator of action-embedded transformational leadership in Apache teams includes being respected as a role model in the team. In voluntary self-managing teams, role modeling is a crucial way of motivating others to do work and to do it in a certain way

because nobody has formal authority to impose these behaviors over others. Sixteen interviewees mentioned the importance of role modeling as highlighted in the following direct quotes from the transcriptions:

S/He doesn't force us. And s/he shows us what is wrong or right by doing it [the work]. Generally, his (her) ideas are true (good). You clearly see that.

S/He has the reverence in the community. It's not like we worship him (her) or anything but, I even look at him (her) as a mentor and I think a number of the committers probably would agree with that statement. If there is a discussion about work and s/he chimes in with a suggestion, then I would say 99 times out of 100 that's what would end up being the way it's done. S/He has this mannerism about him (her) where s/he's not confrontational and it's sometimes just like your father (mother) is talking to you and showing you the way it should be done in this really benevolent way.

The transformational leaders whom we interviewed were aware of their effect on others since they mentioned how they tried to become role models to the team members by exhibiting the behaviors that they would like to see in others:

I think from the leadership perspective, it is important to sit down and do work, so people see you do it.

You get followed by showing them what you ask them to do. But most importantly, you've gotta be still coding, still getting involved in things. No one here is a manager style person.

You just need to do work; otherwise you become 'Oh, that person's the one who just tells us what to do!' Even at a company that is not good, but in Apache you can't tell them what to do, you've gotta have their respect to get them to do it and you gotta build respect by doing it (the work).

Therefore, the data suggests that, in Apache teams, transformational leaders explicitly use role modeling in order to compensate for lack of formal authority over others. Action-embedded leadership and the resulting role modeling became important tools of the transformational leaders to accomplish their visions for the teams without explicitly announcing these visions ahead of time. Interviews with the transformational leaders brings to light that they have a clear vision for the project, however, our observations on the listserv and interviews with the team members uncover that transformational leaders do not explicitly identify a vision ahead of time, asking others to follow it. Rather, they accomplish these goals slowly over time by contributing pieces of it and by role-modeling the actions they want to see in others.

In this section, we presented how some members' actions caused them to be perceived as transformational leaders. In sum, the model that emerges from the data of action-embedded transformation leadership in Apache teams (Fig. 1) suggests three outcomes related to leadership perception: (1) knowledge perception; (2) guardian perception; and (3) role-model perception. How these leaders accomplish their visions and create transformational changes is detailed in the following section, where we specifically discuss how transformational leaders contributed to team outcomes.

4.3. Strategic influence of action-embedded transformational leadership on systems development

Findings suggest that action-embedded transformational leadership within Apache OSS teams influences team outcomes in the following ways: Perceived leaders' work contributes directly to team effectiveness, and these leaders transform the technological vision.

4.3.1. Action-embedded leadership and SMG-ISDT effectiveness

The main goal of SMG-ISDTs investigated in this study is to develop software that meets the needs of its developers and users. Therefore, by actually doing the software development work, transformational leaders contribute directly to team effectiveness. As part of the Apache and similar OSS cultures, doing work is a prerequisite for basic team membership; yet, all technical contributions are not created equal. While other contributors are perceived as "showing the prerequisite leadership for membership", individuals who contribute above and beyond other contributors and have affected the team outcomes remarkably are seen as transformational leaders. Table 4 provides quotes that exhibit how consistently high contributions of the transformational leaders brought about transformational change in the team's product (outcomes). These patterns, while quite different than the patterns found associated with typical transformational leadership, are not so foreign for some of us. Indeed the work-focused attitudes of transformational leaders in SMG-ISDTs are similar to those of entrepreneurs rather than the typical transformational leaders observed of hierarchical organizations.

While it is possible to gain transformational leader status at the beginning or later in the project life, it is also possible to lose the status quickly, as reflected by the comment of respondent 24 in table 4. This reveals the fluidity of leadership and indicates a need for changing our conception of the SMG-ISDT from a stable one. Moreover it suggests a need for more longitudinal approaches for investigating SMG-ISDT transformational leadership.

4.3.2. Action-embedded leadership and transformation of technology vision

In addition to influencing SMG-ISDT's goal accomplishment, data suggest that action-embedded transformational leadership influences technology vision in a unique way. In fact, transformational leaders refrain from stating a grand vision and asking for followership. One such long-term leaders emphasizes how s/he uses role modeling through action-embedded leadership in ensuring his (her) vision is followed.

Table 4
Examples on the strategic influence of transformational leaders on systems development.

	How individuals provide action-embedded transformational leadership	Strategic influence on systems development
Respondent 3	"S/He has put many hours on the project and thus written most of the code that we use today"	Leader wrote the software core [Contribution to SMG-ISDT effectiveness]
Respondent 7	"S/He is a relatively new member…in the last year or so…But s/he contributed almost fulltime, and introduced so many changes, that s/he changed the way we do things. Now, I have to go back into the code to find out how things are done"	Leader changed the structure (inner workings) of the software code [Transformation of technology vision]
Respondent 18	"I come up with the ideas and draft the code, and s/he takes the code and rewrites it in a way that works much better. S/He makes the code like five times faster"	Leader contributed to software quality and speed. [Contribution to SMG-ISDT effectiveness]
Respondent 22	I have a special vision for [the software], how it should be, and I want to make sure that the people coming in share my vision. So, s/he [the other leader] wanted to make sure the people coming in understood why s/he is so reluctant to accept new feature requests. We are trying to very slowly bring the idea of how to use [our software] what should be new in the next release. We do that by developing the software in that direction and others follow. And this works very well	Leader turned the software into a sub-component for other software by taking away small features that are demanded by a minority. [Transformation of technology vision]
Respondent 24	Yeah I started up the project and brought it into Apache, but I moved onto other things since then, and other team members really made it what it is now. Therefore I can't really say I am a leader of the project	A counter-example: The founder of the project suggests he is not a leader because he has not contributed to the current outcomes of the project

So, you can't just go there and say I define the rules and this is how it gets done. Just about everyone in his project defines the rules, and (they would ask) 'why should I use your rules when my rules are better?' So basically you show how you do it with your work. And you show it (in) many places and many times and other people agree (that) this is a good way to do this.

Leaders' long-term actions provide vision and direction to the team because their significant contributions to both team discussions and actual work create transformational change of the structure and the workings of the team processes and/or the software produced. A transformational leader suggested:

You show that you have that vision, that idea, to demonstrate that it works through code and through discussion on the mailing lists. By doing this over time, one of these guys automatically becomes a leader.

An important aspect of accomplishing a transformational change or a new vision is to start doing the work that changes the software, which often leads others to do the same. An interviewee gave the following example:

Part of it (pursuing your vision) is to take baby steps, because you will never get a community to understand and accept massive change… Which is the hard part. Therefore I worked on one piece at a time, until it built up to change the way the project went. And they joined me in making it happen.

As evident from these first-person accounts, action-embedded leadership is an important aspect of transformational leadership in Apache teams. Such transformational leadership influences team level outcomes by contributing to effectiveness and by organically transforming technology vision.

5. Discussion of the results: theoretical and practical implications

Transformational leadership is important for the IS field due to the leaders' role in transforming organizations with information systems (e.g., Beath, 1991; Huang and Hsu, 2011; Karahanna and Watson, 2006; Stephens et al., 1992). Thus, this study helps bridge the gap in IS literature on members' transformational leadership in team context. The findings of this study have important implications for theory and practice, which will be discussed in the following sections.

5.1. Implications for SMG-ISDT transformational leadership theory

Responding to the call for research in IS on how leadership manifests itself in IS project teams, and especially within SMG-ISDTs, this study develops a model of transformational leadership in SMG-ISDTs based on behaviors identified by interviewees (Faraj and Sambamurthy, 2006). Fig. 2 shows how transformational team leaders emerge and contribute to their teams. We call this new type of transformational leadership observed in SMG-ISDT the *action-embedded transformational leadership.*

Action-embedded leadership presents a major shift in our understanding of leadership in IS. Strategic information systems literature supports the commonly held wisdom that leaders are individuals who provide vision (Avolio et al., 2000; Zigurs, 2003), facilitate work (Carte et al., 2006; Yoo and Alavi, 2004), initiate structure (Avolio et al., 2000), coordinate team's
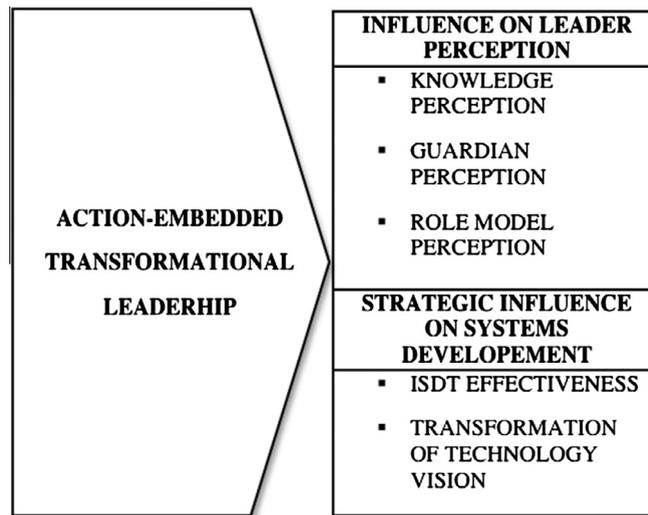
Fig. 2. Theoretical model about transformational SMG-ISDT leadership emergence and influence.

activities (Carte et al., 2006; Maznevski and Chudoba, 2000; Yoo and Alavi, 2004), build camaraderie and trust, develop team members and recognize others (Mitchell and Zigurs, 2009). Doing work, however, has been associated with followers who have been inspired by leaders in traditional organizations. On the other hand, doing work in OSS teams is something one needs to do even to gain participation rights. While members at both the core and the periphery contribute to work, exactly what aspect of their work distinguishes the leaders from the other team members is not clear.

Action-embedded leadership changes our understanding of transformational leadership for SMG-ISDT. While action-embedded transformational leadership emphasizes doing work, most frequently used instruments to measure transformational leadership used in IS measure idealized influence, inspirational motivation, intellectual stimulation, individualized consideration and contingent rewards. Thus, findings emphasize indirect supportive behaviors of transformational leaders. These studies ignore leaders' direct behaviors affecting the work (e.g., Bass and Avolio, 2000; Hoyt and Blascovich, 2003; Karahanna and Watson, 2006; Zhang and Fjermestad, 2006). The underlying assumption of the IS transformational leadership literature is either that the followers of transformational leaders do work or that the work that is done by transformational leaders does not matter from the leadership point of view. This bias may stem from the focus of IS literature on hierarchical settings (e.g., Dhaliwal et al., 2011; Karahanna and Watson, 2006; Leidner et al., 2010; Stephens et al., 1992; Thong et al., 1996; Watts and Henderson, 2006) with some exceptions (e.g., Thomas and Bostrom, 2010). In this study, where formal structures do not automatically define leaders or leadership, the only way transformational leaders emerge is through their work and related communication. Therefore action-embedded leadership is at the core of transformational leadership for SMG-ISDT settings.

Our data show that SMG-ISDT transformational leaders, similar to their hierarchical counterparts in IS and organizational teams, exhibit a clear understanding of the group's future (Podsakoff et al., 1996), create high follower confidence, invite trust and admiration (Bass, 1997), inspire others, lead by example, and are considerate of the feelings of others (Podsakoff et al., 1996).

SMG-ISDT transformational leadership differs from hierarchical IS leadership as follows: First, SMG-ISDT transformational leadership is emergent and thus fluid in that individuals gain or lose leadership through their actions over time. Second, transformational SMG-ISDT leaders do not start off by communicating grand visions. Instead, they accomplish vision by working towards it and setting an example to others to join in. This may be related to not having a formal role that creates expectancies for such grand visions.

Third, while contributions matter for all SMG-ISDT members, transformational leaders' contributions differ from those of others: Indeed as suspected earlier (Fleming and Waguespack, 2005; Howison et al., 2006) all technical contributions are not the same. Those individuals whose work enables others to perceive that they are knowledgeable, that they care about the project's welfare, and those who can be seen as role models as a result of their contributions are viewed as transformational leaders. Transformational leaders work over long periods of time and their contributions strategically contribute to accomplishing a strategic team vision. Moreover, transformational SMG-ISDT leaders' action-oriented leadership motivates others to join in on establishing the same vision and working toward the same goals.

This indicates a need to look at leadership in open source software development teams over time. Secondly, there is a need to take advantage of multiple data sources to compare how individuals technically contribute and whether they are perceived as leaders. For example, it is possible that individuals who explain their technical solutions on the email listserv before submitting their code are more likely to be perceived as more knowledgeable than those who directly submit their code. These kinds of nuances should further be investigated by crosschecking individuals' actions and their actual behaviors as documented in the archival data over time.

In this study, we illuminate how the leaders' behaviors influence individuals and team outcomes. Hence, we address a conceptual weaknesses of existing literature, namely the overemphasis on leader's influence on individuals at the expense of explaining leader's influence on individual processes and group outcomes (Yukl, 1999).

5.2. Implications for practice

This research study provides practical guidance for companies that seek to utilize or increase the efficiency of their SMG-ISDTs. In the next paragraph, we discuss the implications of this study for IS managers. Then, in the remainder of this section, we discuss the implications for practitioners who participate in SMG-ISDTs, referred to shortly as "practitioners" from here on.

First, IS managers should recognize that the leadership skills needed to run and sustain SMG-ISDT differ substantially. SMG-ISDT effectiveness depends on selecting knowledgeable team members who can emerge as leaders based on their work and communication, rather than assigning leaders. Allowing time for the team development and leader emergence is also the key to leadership success.

Based on this research, the practitioners can and perhaps should start leading and transforming their teams without waiting to gain a formal status. It is important to note that all SMG-ISDT members observe each other's work and communications and evaluate each other's "leaderness". Practitioners can influence others' perception by substantively contributing to the group's task over long periods of time. The practitioners should understand that even with substantive contribution, they will not immediately be perceived as a leader. How long it takes individuals to be perceived as a leader may vary across different teams depending on various factors, which are not explained by this study.

In influencing the vision and the future of the SMG-ISDTs, participants can identify their own vision and then divide this vision into smaller and meaningful tasks. They should be ready to initiate and possibly complete some or many of these tasks themselves while at the same time being a role model to others who may follow their lead and also work towards completing these tasks. This way of transforming an SMG-ISDT's technology vision may be much more achievable and much less controversial than trying to convince all team members of the importance of a new grand technology vision and getting them to do work toward that vision. In achieving team effectiveness and transforming the technology vision, the SMG-ISDT participants should opt for being a role model through their action-embedded transformational leadership, rather than trying to influence individuals solely through communication.

Lastly, the transformational leaders in this study were perceived to be knowledgeable about IS and to be the guardians of the project. Therefore, we would recommend the aspiring practitioners to act like these transformational leaders in order to be seen as one. This would require that they communicate their ideas based on clear, well-explained reasoning which depends on their knowledge of the IS project. Such communication will increase the likelihood that their ideas are understood and appreciated by others. It will also ensure that practitioner's knowledge on the topic is understood. Furthermore, practitioners should always protect the group's work and positive environment and their actions should reflect this concern. Similarly, they should behave in ways that are seen as ideal to the members of the group. This may require respecting and abiding by the written and non-written norms of the group, and supporting the other members.

6. Conclusions, limitations and future research

This study responds to the call for understanding leadership in IS development teams, which requires unique skills and behaviors (Faraj and Sambamurthy, 2006). The results of this study provided empirical evidence to the IS transformational leader behaviors, such as *inspiring others*, *leading by example*, and *being considerate of others' feelings*, identified in extant literature on organization teams (e.g., Podsakoff et al., 1996).

The unique contribution of this study is the finding that SMG-ISDT transformational leaders exhibit action-embedded transformational leadership. This suggests that practitioners need to be actively engaged in teams' work in order to emerge as transformational leaders. This presents a major shift in our understanding of leadership in the IS field. Current IS leadership literature emphasizes vision development (e.g., Avolio et al., 2000; Zigurs, 2003) and team member management and facilitation (e.g., Mitchell and Zigurs, 2009) instead of leaders' actions that directly contribute to IS development.

We found that action-embedded transformational leadership causes others to perceive individuals to be knowledgeable role models who guard their project. Emergent leaders strategically influence technology development through their action-embedded transformational leadership, which contributes to team effectiveness and transforms team's technology vision. Thus practitioners can contribute to work in significant ways that can slowly transform the team's work, and at the same time influence other's perceptions about their knowledge level. Besides contributing to the work, practitioners should make decisions that protect the project and its members, and be a role model to others. This type of leadership, where a team member is both transforming the team's work outcomes, and is influenced by this transformation, is uniquely different than the earlier organizational transformation literature, which focuses either on the actors who initiate the transformation or those who undergo it (Besson and Rowe, 2012).

Another important contribution of this study to the extant literature on organizational transformations leadership is our research model. Typically, organizational transformational leadership literature ignores leaders' direct behaviors that affect the work, perhaps, due to the hierarchical setting, in which this literature is typically embedded (Bass and Avolio, 2000). This brings about the question of whether IS leadership in general, and IS transformational leadership in particular, should focus

on hierarchical top-down leadership or a flat bottom-up leadership. Indeed, Peppard and Ward (1999) discuss that the leadership research in strategic information systems literature focuses on the information systems leadership of CIO's, IS directors, and CEOs. We acknowledge the strategic importance of this type of leadership. Yet an important conclusion of our work is the understanding that strategic IS leadership is also provided by emergent team leaders, which should not be neglected by IS research. In fact, Merali et al. (2012) identify the focus on formal leaders as a trend of the 1990s and highlight the increasing importance of network structure in the 2000s, which makes bottom-up transformational leadership more relevant. This requires the IS researchers to investigate how emergent leaders contribute to Business-IS alignment, and to competitive advantage via the selection and use of information systems.

The findings of this study are generalizable to other SMG teams that reside in a broader organizational context similar to that in this study. Examples include organizational self-managing global IS development and implementation teams, organizational open source software teams, non-profit organizations, global research collaborations, and task forces in companies and civil society organizations.

One limitation of this study is the sole dependence on interviews in developing a model of transformational leadership. Interviews are useful devices for eliciting leadership perception and they have provided rich data and meaningful findings for this study. Nowadays, OSS offers researchers an unprecedented access to data on member behaviors (von Krogh and Spaeth, 2007). Combining these different sources of data is recommended for future research to capture a finer understanding of the connection between leadership perception and leader behaviors.

In this study, action-embedded transformational leadership referred mainly to leaders' work, and to a lesser extent their communication. This is quite different than SMG team research in the information systems field (Yoo and Alavi, 2004) and the global team transformational leadership research (e.g., Balthazard et al., 2009), where the activity levels of the leaders refer to the extent that these leaders initiate communication. The divergence of our findings from this literature stream warrants future research on whether action-embedded transformational leadership or babble hypothesis (the idea that individuals gain leadership through their communication) seem to be superior indictors of leadership emergence.

Lastly, the dynamic nature of the action-oriented transformational leadership became clear as the interviewees mentioned how they may gain and lose leadership status in the eyes of participants. Further research is needed to identify specific leadership behaviors of SMG-ISDT leaders and how their behaviors may change over time. Longitudinal studies in this area are long overdue in order to understand how these leadership behaviors manifest and change as the nature of team membership changes.

Acknowledgements

Appendix A. Interview protocol

A.1. Part I: Respondent identification questions

(1) General/demographic Questions
  (a) Can you tell me a bit about yourself?
  (b) How long have you been involved with Apache?
  (c) Which projects are you involved in?
  (d) What is your role in these projects?
  (e) What is the level of your involvement in these projects?
     (i) Prompt: How long have you been involved with the project
  (f) How many people do you work with in your project/sub-project?
  (g) Are you paid by your employer to work on this project?

A.2. Part II

(2) Can you identify some key players in your team? What is their role in the team's work? How do they contribute to the team?
(3) How does your team make strategic decisions that affect the whole team?

(4) Can you describe your team and its members a little bit? How close are they? How do they work together, etc.?
(5) Can you describe how you guys work together? Communicate?
(6) Are there particular members of the team whom you feel...
    (a) make a particularly strong technical contribution,
    (b) contribute to keeping the group together, (maintain good relationships, help set a positive tone in the group, resolve disputes, welcome new members, recognize contributions, ensure that people stick around)
    (c) help coordinate the work
    (d) represent the project to other communities?
(7) Are there particular members of the team who you feel...
    (a) have changed the way people think about the project (the project goals, users, the important functionality of the software, the best way to achieve the goals)?
    Prompt: How did they do that?
    (b) have defined roles in the project?
    Prompt: How did they do that?
    (c) have set formal or informal rules for the project?
    Prompt: How did they do that?

A.3. Part III

(8) Are there one or more people whom you think of as leaders of the project?
If answer is yes => identify who they are.
For each leader, ask the following questions

    (a) What makes you think that s/he is a leader?
    (b) How does s/he affect how the work is done?
    (c) What else does the leader affect or support?

If the answer is no to the first question=>

    (a) Oh, that's interesting, tell me more...
    (b) Do you have formal administrators, though? If yes=> why do you think they aren't leading the group?
    (9) Has leadership changed over time? If so, what caused it to change?

Appendix B. Coding schema

Code name	Coding process/description	Example
Influence on leader perception	(1) Use this code when the interviewee answers the question "why do you think of him/her as a leader" by describing leader behaviors that lead the interviewee to see this person as a leader	"Why do they think of you as a leader?"
	(2) Mark the text with the code "strategic influence on leader perception", when the interviewees connect leader behaviors to how they perceive that person as a leader. Then recode this quote or a sub-part of it with the three sub-codes below	"I am just being my egoistical self, by writing the (software) code and doing things that I enjoy and then it sort of works out that it is for the common good"
IT-knowledge perception	Recode the whole or part of the text that was originally coded with "strategic influence on leader perception" with this code when the interviewee indicates specific knowledge and experience of the leader on Open Source, on the project or aspects of the project/code	"When you find someone as him/her, then of course he should be the leader. S/he has all the experience on the subject"
Guardian perception	Recode the whole or part of the text that was originally coded with "strategic influence on leader perception" with this code when the interviewee remarks on how the leaders protect the project, do what is good for the project and avoid behaviors that would hurt the project or damage the team	"S/He's established a great deal of respect for her/him by dealing with the social aspects... S/he protected the community break-down once by resolving a problem by an outsider who constantly emailed the mailing-list and verbally attacked its members"

Coding schema (*continued*)

Code name	Coding process/description	Example
Role-model perception	Recode the whole or part of the text that was originally coded with "strategic influence on leader perception" with this code when the interviewee comments on the leader acting in ways that becomes a role model for others.	"You see him/her doing good things for the project, then you want to do the same"
Strategic influence on systems development	Use this code when the interviewee states how the leader or his/her leadership contributes to the team outcomes	"He's improved the whole documentation. He's the guy who most of us look to for organizing that information"
SMG-ISDT effectiveness	Recode the whole or part of the text that was originally coded with "Strategic Influence on Technology Development" with this code when the interviewee remarks on how the team leader helped achieve the team's goal of developing software code or other team goals such as developing a high quality code, etc.	"If someone is technically making a mess of things, I just fix it, and fix it, and fix it, and fix it. And people will notice when you fix their mistakes because all the changes go through a mailing list. Then, in effect, you've increased the software quality by improving what they did and teaching them how to do better in the future"
Transformation of technology vision	Recode the whole or part of the text that was originally coded with "Strategic Influence on Technology Development" with this code when the text implies that the leader transforms the team's technology vision, provides a direction for how the software should be or on team processes	"One or two of them are actually guiding the development at the moment, and they say, 'yes I have the idea of what project should go'"

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